International Aircraft Systems Fire Protection Working Group Meeting

Updated Experimental Investigation of the NexGen Burner

Fire Test Center

University of Cincinnati, Cincinnati, OH, USA

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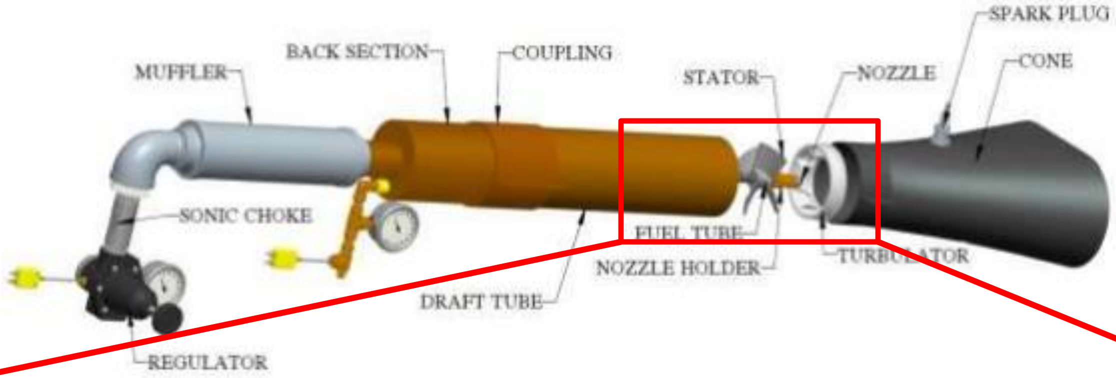
Project Overview

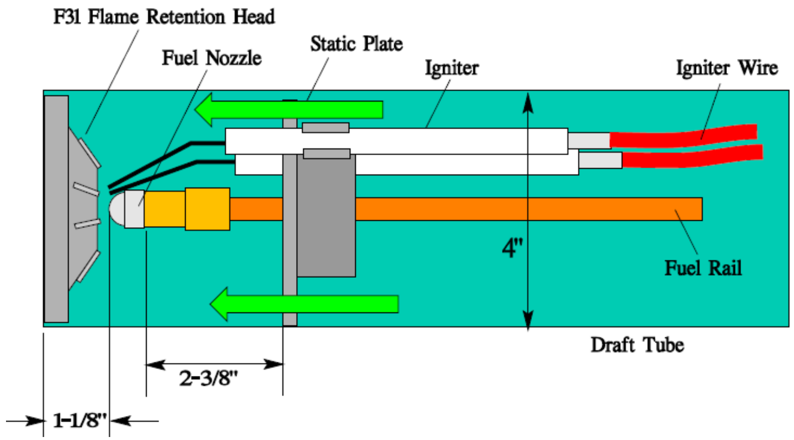
- Project Objective:
  - To compare the ignitorless stator burner configuration with the configuration which utilizes a flame retention head.
  - Additional tests studying the effect of backside temperatures for varying room air velocities will be presented (Oil Burner Cargo Liner tests)
- Previous Work
  - Old Configuration (Turbulator & Stator):
    - Effect of burner setup and calibration TC size on burner
    - Sensitivity of burner to air and fuel flow rates and temperature
    - Effect of burner orientation on burner performance
    - Comparison of fire test results between NexGen and Gas burners
  - New Configuration (FRH):
    - Fuel spray and temperature maps for different FRHs and fuel nozzles
    - Burn through and temperature maps of varying fuel/air operating settings
    - Fuel nozzle spray characterization and comparison
    - Sensitivity of burner to assembly tolerance
    - Effect of test fixture design, burner inclination, and use of ceramic insulation

Current Approach

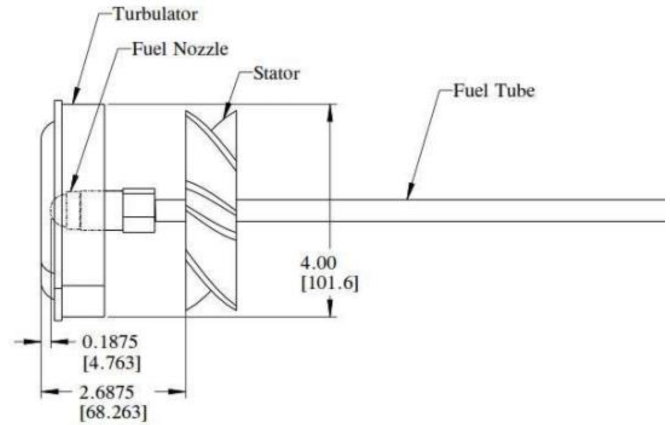
- Comparison of two burner configurations
  - Ignitorless Stator
  - Flame Retention Head
- Performance Comparison
  - Burn Through Tests
  - Temperature Maps
- Effect of Air Velocity on Backside Temperature
  - Results of Oil Burner Cargo Liner Tests

Burner Configurations





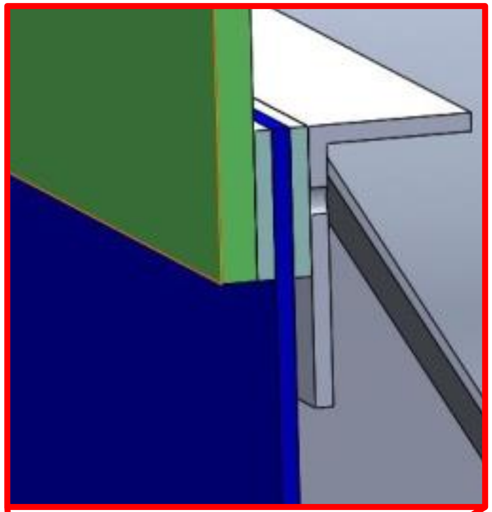
Flame Retention Head

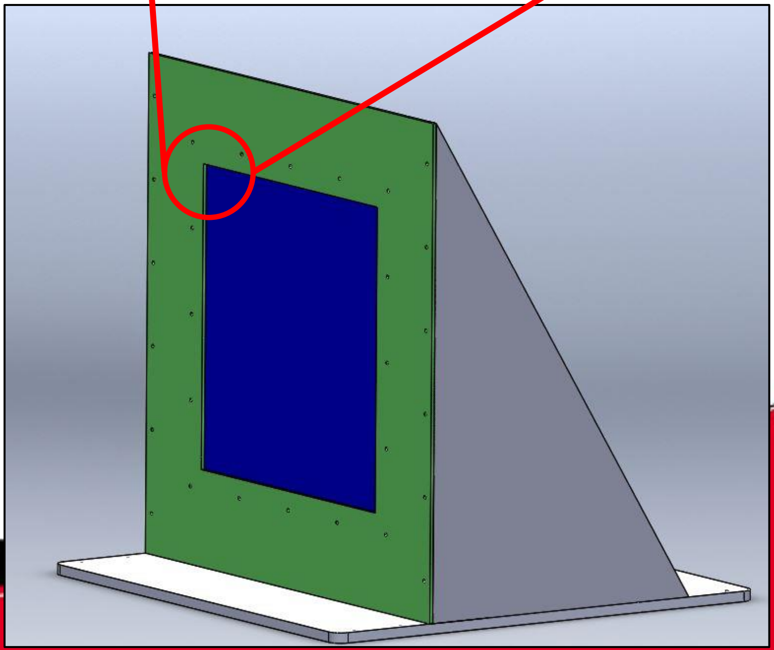


Ignitorless Stator

Burn Through Test

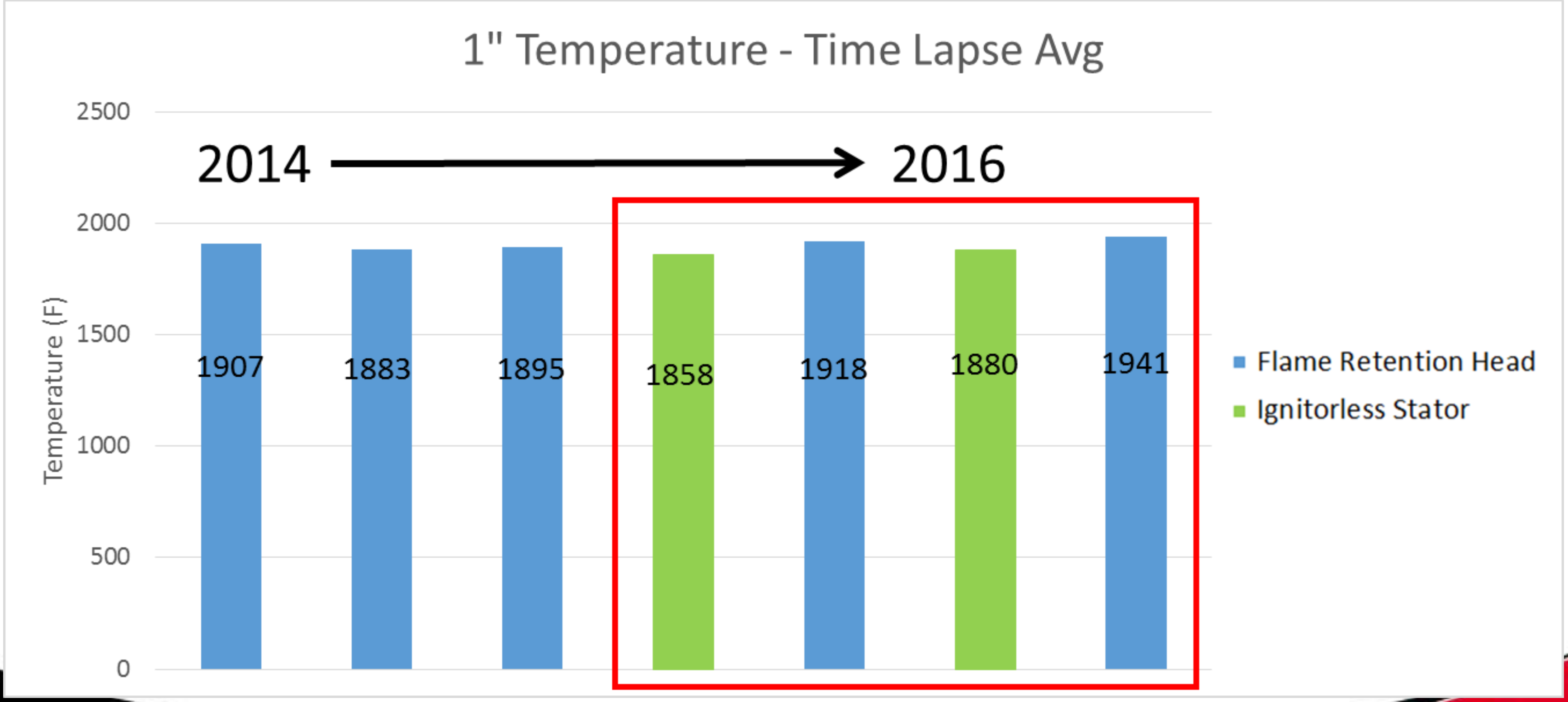
- Air Flow Settings
  - 50 psig (265 PPH), 50 ºF
- Fuel Flow Settings
  - 109 psi (2.5 GPH), 42 ºF
- Test Sample
  - 2024 Aluminum Panel
  - 24 x 24 x 0.125”





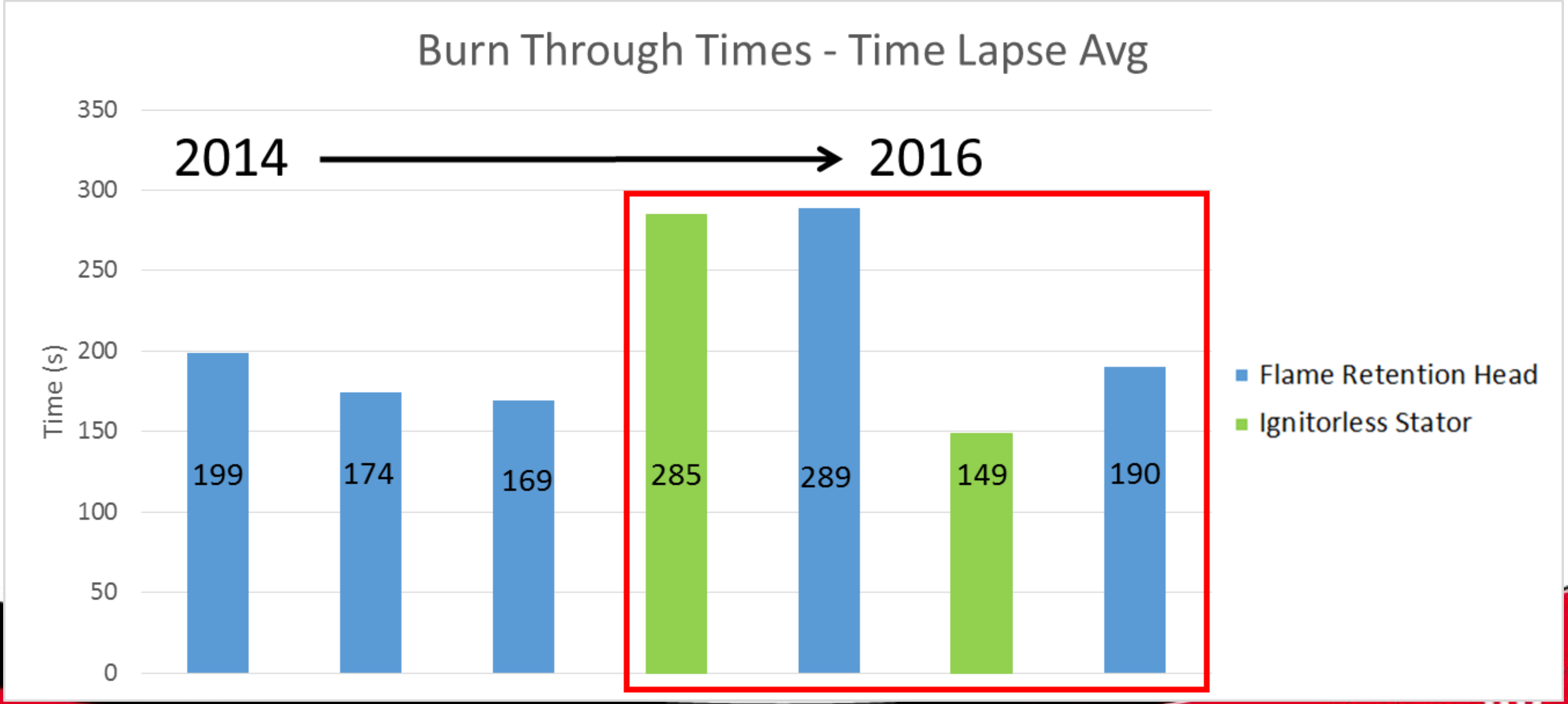
Calibration Results

- Temperatures at 1” calibration line are very consistent from year to year and between burner configurations



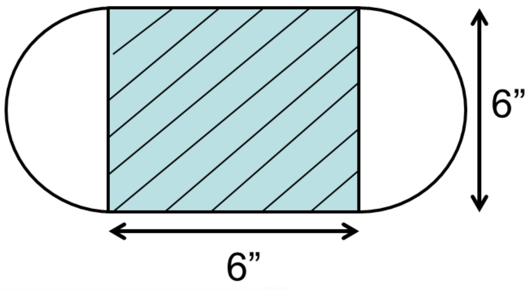
Burn Through Test

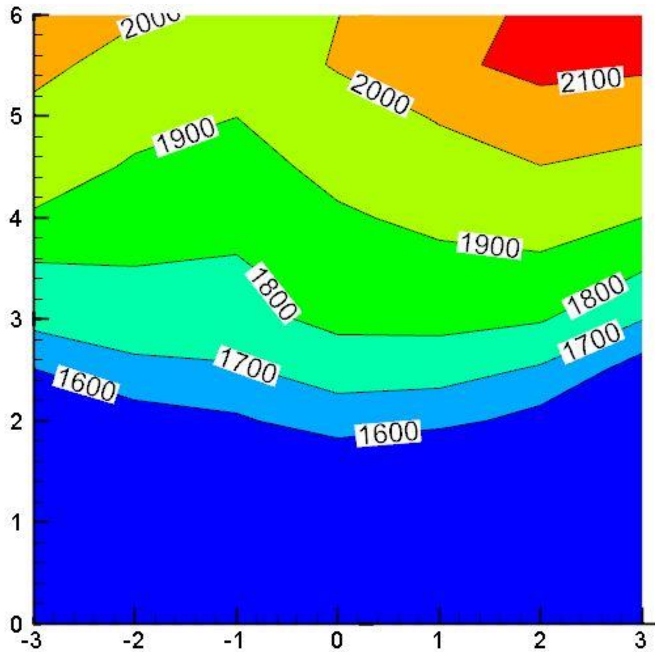
- Good burn through repeatability for Baseline test
  - In general, burn through is 185 ±30 sec
  - Large outliers recorded in first iteration of testing this year, and are being looked into



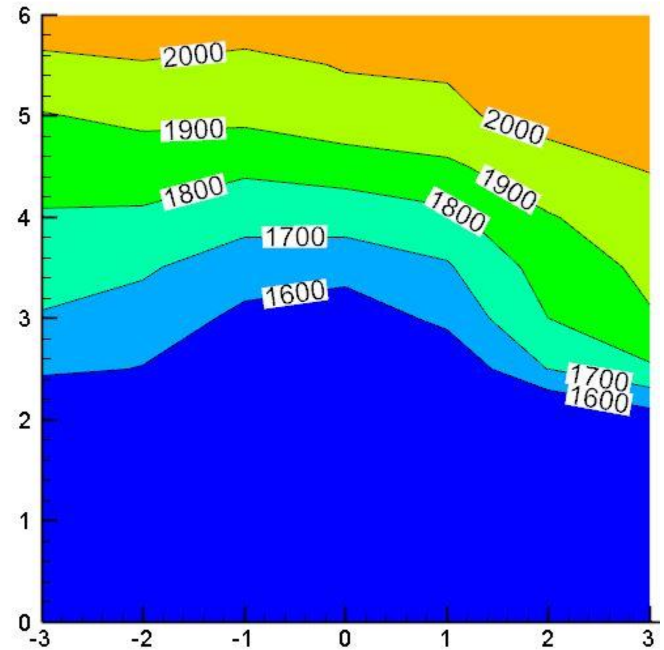
Burner Configuration – Temperature Maps

- Area of measurement: 6x6” square in center of burner (see figure to the right)
- Temperature plots are an average of 3 cases

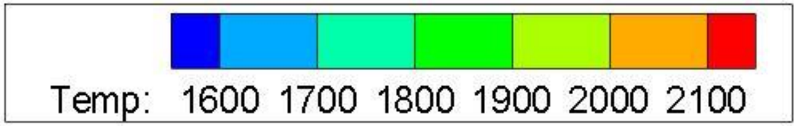




Ignitorless Stator



Flame Retention Head



Conclusions and Recommendations

- Summary
  - Temperatures remain consistent at aforementioned air and fuel settings, regardless of burner configuration or time lapse view of data
  - Burn through times are repeatable within each configuration, and results between both configurations agree with each other
  - Some outliers which will be investigated
- Recommendations
  - Move to ignitorless stator burner configuration to increase set-up simplicity

Effect of Air Velocity on Oil Burner Cargo Liner Test

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Background

- The FAA is working to quantify the factors which lead to large discrepancies in backside temperature measurements across test houses, as observed in Oil Burner Cargo Liner tests
- One such factor is the magnitude and direction of ambient air velocity in the test cell
- Tests were conducted on fiberglass composite samples using the NexGen burner in a vertical orientation. The test article is positioned 8 inches above the burner exit plane. A 1/16" Type K TC is located 4 inches above the test article and measures temperature during the test
- Backside temperature was recorded for a test duration of 5 minutes. In 'real' Oil Burner Cargo Liner tests, material failure occurs if the temperature rises above 400 F
- In testing identical fiberglass composite samples across participating test houses, discrepancies of up to 125 F were observed, using the same burner configuration and operating conditions

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Current Approach

- Variation of ambient air velocity via exhaust setpoint
  - Low, medium and high velocity

Fan Setpoint	Air Direction	Velocity (feet/min)
25 Hz	Vertical	17.7
	Horizontal	19.7
45 Hz	Vertical	29.5
	Horizontal	25.6
60 Hz	Vertical	49.2
	Horizontal	78.7

- Effect of thermocouple sheath
  - Eliminate horizontal velocity component

Fan Setpoint	Thermocouple
25 Hz	Unsheathed
	Sheathed

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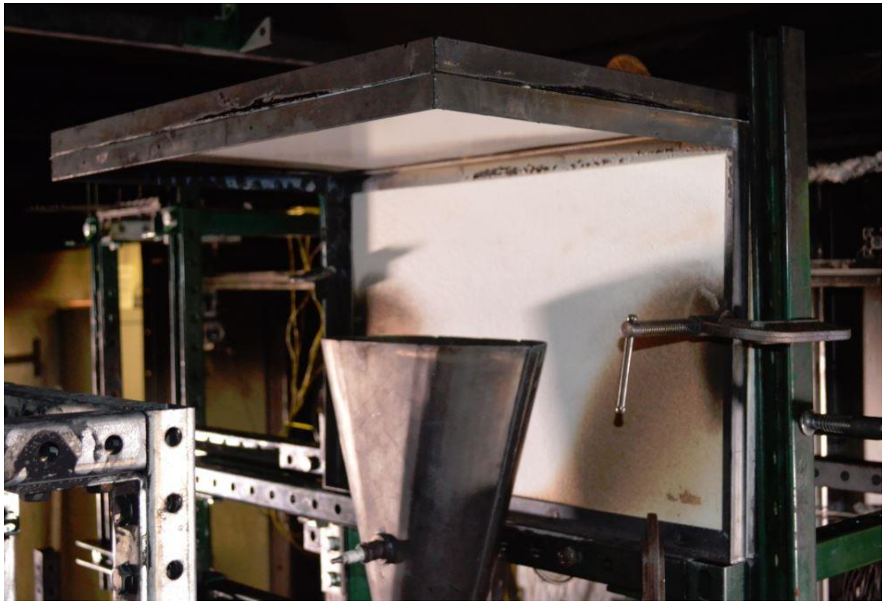
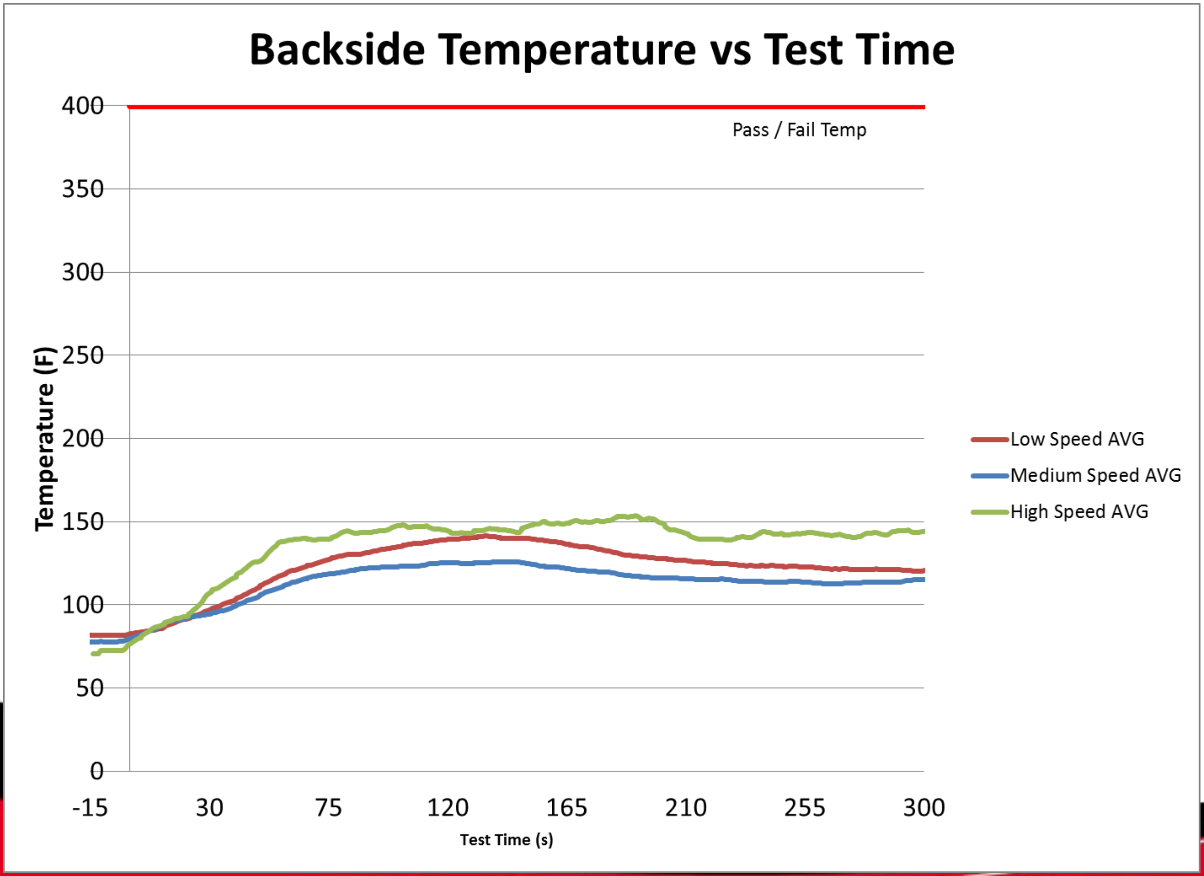
Test Set Up



Results

- Air velocity has an observable effect on backside temperatures, though not to a significant extent over the range of conditions tested here



49 feet/min vertical
79 feet/min horizontal

18 feet/min vertical
20 feet/min horizontal

30 feet/min vertical
26 feet/min horizontal

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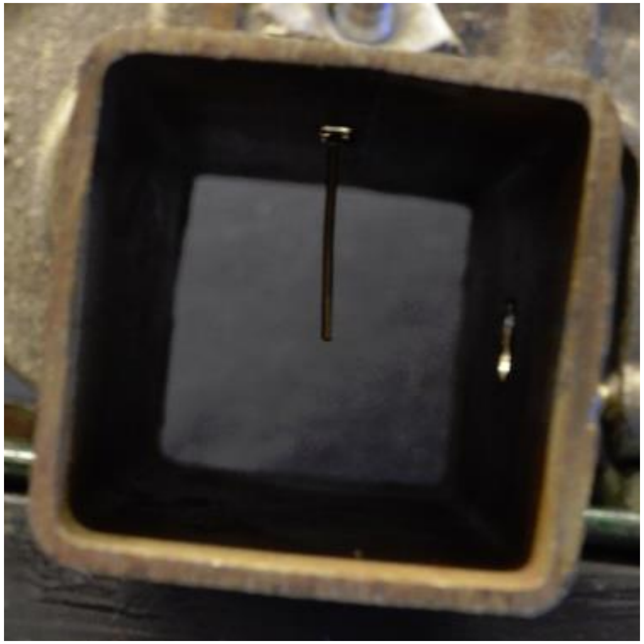
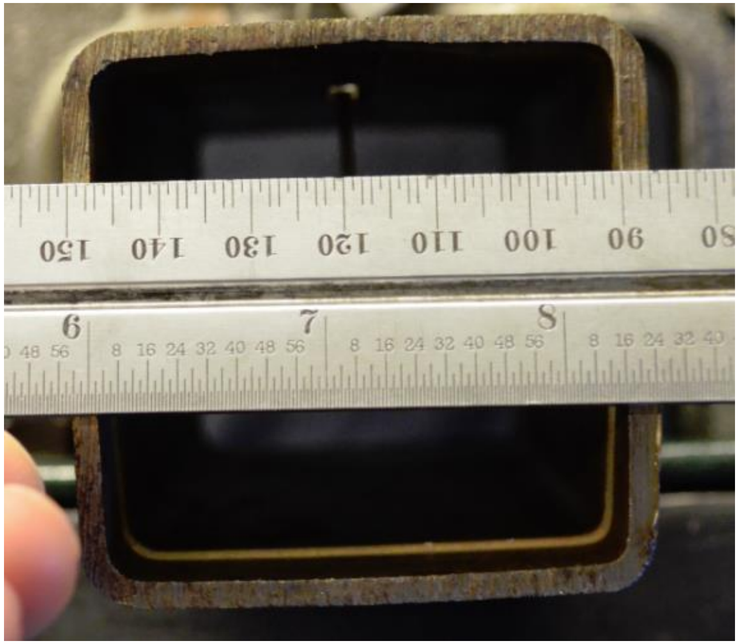
Sheath





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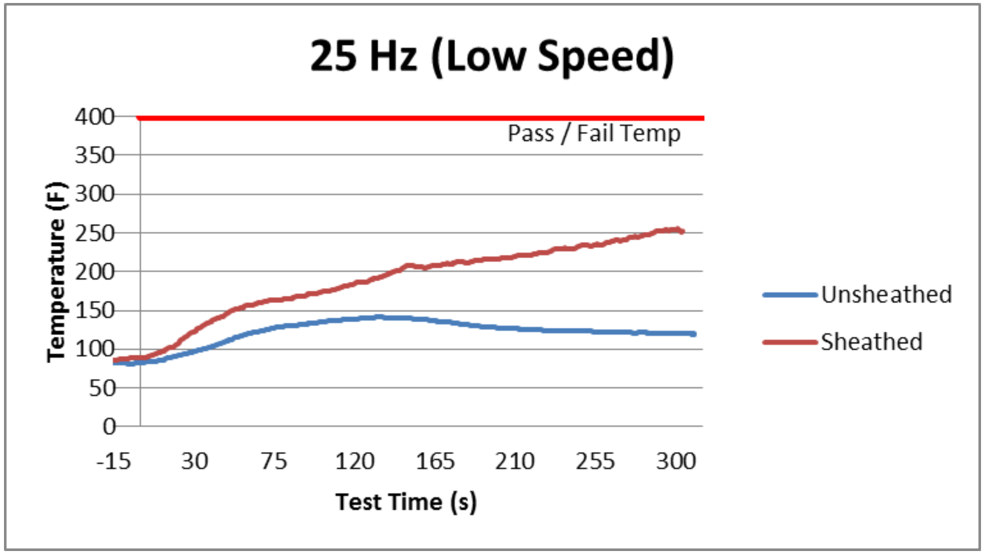
Results

- Radiation heat transfer from the sheath could have increased temperature measurements
- The horizontal component of air flow across the test article can have a significant impact on test results.



Conclusions and Recommendations

- Summary
  - Ambient air velocity inside test cell has some impact on backside temperature and test results. Impact was minimal over the range of velocities tested here. More extreme cases could cause significant impact
  - The horizontal component of air velocity is seen to cause a significant effect, though the contribution of radiation heat transfer is yet unknown
  - More testing may be required to further characterize the influence of air velocity around a test article
- Recommendations
  - Specify a range of acceptable vertical and horizontal test cell air velocities in the Handbook, at specific points relative to the test sample